

**What is claimed is:**

1           1.     An           organically-functionalized           carbon  
2     nanocapsule, comprising:

3                 a carbon nanocapsule; and

4                 at least one kind of organic functional groups  
5                 bonded thereon,

6                 wherein the organically-functionalized carbon  
7                 nanocapsule is of the following formula:

8                  $F(-E)_n$ , in which F is the carbon nanocapsule, E  
9                 is the organic functional group, and n is  
10                 the number of the organic functional  
11                 group.

12           2.     The           organically-functionalized           carbon  
13     nanocapsule as claimed in claim 1, wherein the carbon  
14     nanocapsule is a polyhedral carbon cluster constituting  
15     multiple graphite layers having a balls-within-a ball  
16     structure, and the diameter of a carbon nanocapsule is 3-  
17     100 nm.

1           3.     The           organically-functionalized           carbon  
2     nanocapsule as claimed in claim 1, wherein the carbon  
3     nanocapsule is hollow.

1           4.     The           organically-functionalized           carbon  
2     nanocapsule as claimed in claim 1, wherein the carbon  
3     nanocapsule is a metal-filled carbon nanocapsule filled  
4     with metals, metal oxides, metal carbides, or alloys.

5. The organically-functionalized carbon nanocapsule as claimed in claim 1, wherein n is 1-100,000.

6. The organically-functionalized carbon nanocapsule as claimed in claim 1, wherein each E is independently E<sub>1</sub>, E<sub>2</sub>, E<sub>3</sub>, E<sub>4</sub> or E<sub>5</sub>, in which each E<sub>1</sub>, independently, is Y<sub>1</sub>,Y<sub>2</sub> -amino, (Y<sub>1</sub>,Y<sub>2</sub> -alkyl)amino, Y<sub>1</sub>,Y<sub>2</sub> -ethylenediamino, (dihydroxymethyl)alkylamino, (X<sub>1</sub>,X<sub>3</sub> -aryl)amino, or X<sub>1</sub>,X<sub>3</sub> -aryloxy; each E<sub>2</sub>, independently, is Y<sub>1</sub>,Y<sub>2</sub> -alkoxy, (Y<sub>1</sub>,Y<sub>2</sub> -amino)alkoxy, (Y<sub>1</sub>,Y<sub>2</sub>,Y<sub>3</sub> -aryl)oxy, (dihydroxyalkyl)aryloxy, (Y<sub>1</sub>,Y<sub>2</sub>,Y<sub>3</sub> -alkyl)amino, (Y<sub>1</sub>,Y<sub>2</sub>,Y<sub>3</sub> -aryl)amino, or dihydroxyalkylamino; each E<sub>3</sub>, independently, is Y<sub>1</sub>,Y<sub>2</sub>,Y<sub>3</sub> -alkoxy, (trihydroxyalkyl)alkoxy, (trihydroxyalkyl)alkylamino, (dicarboxyalkyl)amino, (Y<sub>1</sub>,Y<sub>2</sub>,Y<sub>3</sub> -alkyl)thio, (X<sub>1</sub>,X<sub>2</sub> -aryl)thio, (Y<sub>1</sub>,Y<sub>2</sub> -alkyl)thio, (dihydroxyalkyl)thio, Y<sub>1</sub>,Y<sub>2</sub> -dioxoalkyl; each E<sub>4</sub>, independently, is ((glycosidyl)oxoheteroaryl)amino, ((glycosidyl)oxoaryl)amino, (X<sub>1</sub>,X<sub>2</sub>,X<sub>3</sub> -heteroaryl)amino, (X<sub>1</sub> -diarylketone)amino, (X,X<sub>1</sub> -oxoaryl)amino, (X,X<sub>1</sub> -dioxoaryl) amino, (Y<sub>1</sub> -alkyl, Y<sub>2</sub> -alkyldioxoheteroaryl)amino, (Y<sub>1</sub> -alkyl, Y<sub>2</sub> -alkyldioxoaryl)amino, (di(Y<sub>1</sub>,Y<sub>2</sub> -methyl)dioxoheteroaryl)amino, (di(Y<sub>1</sub>,Y<sub>2</sub> -methyl)dioxoaryl)amino, ((glycosidyl)heteroaryl)amino, ((glycosidyl)aryl)amino, ((carboxylacetylalkyl)oxoheteroaryl)amino, ((carboxylacetylalkyl)oxoaryl)amino, ((isopropylaminohydroxyalkoxy)aryl)amino, or (X<sub>1</sub>,X<sub>2</sub>,X<sub>3</sub> -

alkylaryl)amino; each E<sub>5</sub>, independently, is (X<sub>1</sub>,X<sub>2</sub>,X<sub>3</sub> - heteroaryl)oxy, (isopropylaminohydroxyalkyl)aryloxy, (X<sub>1</sub>,X<sub>2</sub>,X<sub>3</sub> -oxoheteroaryl)oxy, (X<sub>1</sub>,X<sub>2</sub>,X<sub>3</sub> -oxoaryl)oxy, (X<sub>1</sub>,Y<sub>1</sub> -oxoheteroaryl)oxy, (X<sub>1</sub> -diarylketone)oxy, (X,X<sub>1</sub> -oxoaryl)oxy, (X<sub>1</sub>,X<sub>2</sub> -dioxoaryl)oxy, (Y<sub>1</sub>,Y<sub>2</sub>,di-aminodihydroxy)alkyl, (X<sub>1</sub>,X<sub>2</sub> -heteroaryl)thio, ((tricarboxylalkyl)ethylenediamino)alkoxy, (X<sub>1</sub>,X<sub>2</sub> -oxoaryl)thio, (X<sub>1</sub>,X<sub>2</sub> -dioxoaryl)thio, (glycosidylheteroaryl)thio, (glycosidylaryl)thio, Y<sub>1</sub> -alkyl(thiocarbonyl)thio, Y<sub>1</sub>,Y<sub>2</sub> -alkyl(thiocarbonyl)thio, Y<sub>1</sub>,Y<sub>2</sub>,Y<sub>3</sub> -alkyl(thiocarbonyl)thio, (Y<sub>1</sub>,Y<sub>2</sub> -aminothiocarbonyl)thio, (pyranosyl)thio, cysteinyl, tyrosinyl, (phenylalainyl)amino, (dicarboxyalkyl)thio, (aminoaryl)<sub>1-20</sub> amino, or (pyranosyl)amino;

each X, independently, is halide; each of X<sub>1</sub> and X<sub>2</sub>, independently, is --H, --Y<sub>1</sub>, --O--Y<sub>1</sub>, --S--Y<sub>1</sub>, --NH--Y<sub>1</sub>, --CO--O--Y<sub>1</sub>, --O--CO--Y<sub>1</sub>, --CO--NH--Y<sub>1</sub>, --CO--NY<sub>1</sub>Y<sub>2</sub>, --NH--CO--Y<sub>1</sub>, --SO<sub>2</sub>--Y<sub>1</sub>, --CHY<sub>1</sub>Y<sub>2</sub>, or --NY<sub>1</sub>Y<sub>2</sub>; each X<sub>3</sub>, independently, is --Y<sub>1</sub>, --O--Y<sub>1</sub>, --S--Y<sub>1</sub>, --NH--Y<sub>1</sub>, --CO--O--Y<sub>1</sub>, --O--CO--Y<sub>1</sub>, --CO--NH--Y<sub>1</sub>, --CO--NY<sub>1</sub>Y<sub>2</sub>, --NH--CO--Y<sub>1</sub>, --SO<sub>2</sub>--Y<sub>1</sub>, --CHY<sub>1</sub>Y<sub>2</sub> or --NY<sub>1</sub>Y<sub>2</sub>;

each of Y<sub>1</sub>, Y<sub>2</sub> and Y<sub>3</sub>, independently, is --B--Z;

each B, independently, is --R<sub>a</sub>--O--[Si(CH<sub>3</sub>)<sub>2</sub>--O--]<sub>1-100</sub>, C<sub>1-2000</sub> alkyl, C<sub>6-40</sub> aryl, C<sub>7-60</sub> alkylaryl, C<sub>7-60</sub> arylalkyl, (C<sub>1-30</sub> alkyl ether)<sub>1-100</sub>, (C<sub>6-40</sub> aryl ether)<sub>1-100</sub>, (C<sub>7-60</sub> alkylaryl ether)<sub>1-100</sub>, (C<sub>7-60</sub> arylalkyl ether)<sub>1-100</sub>, (C<sub>1-30</sub> alkyl thioether)<sub>1-100</sub>, (C<sub>6-40</sub> aryl thioether)<sub>1-100</sub>, (C<sub>7-60</sub> alkylaryl thioether)<sub>1-100</sub>, (C<sub>7-60</sub> arylalkyl thioether)<sub>1-100</sub>,

55 (C<sub>2-50</sub> alkyl ester)<sub>1-100</sub>, (C<sub>7-60</sub> aryl ester)<sub>1-100</sub>, (C<sub>8-70</sub>  
56 alkylaryl ester)<sub>1-100</sub>, (C<sub>8-70</sub> arylalkyl ester)<sub>1-100</sub>, --R--CO--  
57 O--(C<sub>1-30</sub> alkyl ether)<sub>1-100</sub>, --R--CO--O--(C<sub>6-40</sub> aryl ether)<sub>1-</sub>  
58 100, --R--CO--O--(C<sub>7-60</sub> alkylaryl ether)<sub>1-100</sub>, --R--CO--O--  
59 (C<sub>7-60</sub> arylalkyl ether)<sub>1-100</sub>, (C<sub>4-50</sub> alkyl urethane)<sub>1-100</sub> (C<sub>14-60</sub>  
60 aryl urethane)<sub>1-100</sub>, (C<sub>10-80</sub> alkylaryl urethane)<sub>1-100</sub> (C<sub>10-80</sub>  
61 arylalkyl urethane)<sub>1-100</sub>, (C<sub>5-50</sub> alkyl urea)<sub>1-100</sub>, (C<sub>14-60</sub> aryl  
62 urea)<sub>1-100</sub> (C<sub>10-80</sub> alkylaryl urea)<sub>1-100</sub>, (C<sub>10-80</sub> arylalkyl urea)  
63 1-100, (C<sub>2-50</sub> alkyl amide)<sub>1-100</sub>, (C<sub>7-60</sub> aryl amide)<sub>1-100</sub>, (C<sub>8-70</sub>  
64 alkylaryl amide)<sub>1-100</sub> (C<sub>8-70</sub> arylalkyl amide)<sub>1-100</sub>, (C<sub>3-30</sub>  
65 alkyl anhydride)<sub>1-100</sub>, (C<sub>8-50</sub> aryl anhydride)<sub>1-100</sub>, (C<sub>9-60</sub>  
66 alkylaryl anhydride)<sub>1-100</sub>, (C<sub>9-60</sub> arylalkyl anhydride)<sub>1-100</sub>,  
67 (C<sub>2-30</sub> alkyl carbonate)<sub>1-100</sub>, (C<sub>7-50</sub> aryl carbonate)<sub>1-100</sub>, (C<sub>8-60</sub>  
68 alkylaryl carbonate)<sub>1-100</sub>, (C<sub>8-60</sub> arylalkyl carbonate)<sub>1-100</sub>, -  
69 -R<sub>1</sub>--O--CO--NH--(R<sub>2</sub> or Ar--R<sub>2</sub>--Ar)--NH--CO--O--(C<sub>1-30</sub> alkyl  
70 ether, C<sub>6-40</sub> aryl ether, C<sub>7-60</sub> alkylaryl ether, or C<sub>7-60</sub>  
71 arylalkyl ether)<sub>1-100</sub>, --R<sub>1</sub>--O--CO--NH--(R<sub>2</sub> or Ar--R<sub>2</sub>--Ar)-  
72 -NH--CO--O(C<sub>2-50</sub> alkyl ester, C<sub>7-60</sub> aryl ester, C<sub>8-70</sub>  
73 alkylaryl ester, or C<sub>8-70</sub> arylalkyl ester)<sub>1-100</sub>, --R<sub>1</sub>--C--CO--  
74 -NH--(R<sub>2</sub> or Ar--R<sub>2</sub>--Ar)--NH--CO--O--(C<sub>1-30</sub> alkyl ether, C<sub>6-40</sub>  
75 aryl ether, C<sub>7-60</sub> alkylaryl ether, or C<sub>7-60</sub> arylalkyl  
76 ether)<sub>1-100</sub>, --CO--NH--(R<sub>2</sub> or Ar--R<sub>2</sub>--Ar)--NH--CO--O--, --R<sub>1</sub>  
77 --O--CO--NH--(R<sub>2</sub> or Ar--R<sub>2</sub>--Ar)--NH--CO--O--(C<sub>2-50</sub> alkyl  
78 ester, C<sub>7-60</sub> aryl ester, C<sub>8-70</sub> alkylaryl ester, or C<sub>8-70</sub>  
79 arylalkyl ester)<sub>1-100</sub>, --R<sub>3</sub>--O--CO--NH--(R<sub>2</sub> or Ar--R<sub>2</sub>--Ar)--  
80 NH--CO--O--, --R<sub>1</sub>--NH--CO--NH--(R<sub>2</sub> or Ar--R<sub>2</sub>--Ar)--NH--CO--  
81 O--(C<sub>1-30</sub> alkyl ether, C<sub>6-40</sub> aryl ether, C<sub>7-60</sub> alkylaryl  
82 ether, or C<sub>7-60</sub> arylalkyl ether)<sub>1-100</sub>, --R<sub>1</sub>--NH--CO--NH--(R<sub>2</sub>  
83 or Ar--R<sub>2</sub>--Ar)--NH--CO--O--(C<sub>2-50</sub> alkyl ester, C<sub>7-60</sub> aryl  
84 ester, C<sub>8-70</sub> alkylaryl ester, or C<sub>8-70</sub> arylalkyl ester)<sub>1-100</sub>,

--R<sub>1</sub>--NH--CO--NH--(R<sub>2</sub> or Ar--R<sub>2</sub>--Ar)--NH--CO--O--(C<sub>1-30</sub>  
alkyl ether, C<sub>6-40</sub> aryl ether, C<sub>7-60</sub> alkylaryl ether, or C<sub>7-60</sub>  
arylalkyl ether)<sub>1-100</sub>, --CO--NH--(R<sub>2</sub> or Ar--R<sub>2</sub>--Ar)--NH--CO--  
O--, --R<sub>1</sub>--NH--CO--NH--(R<sub>2</sub> or Ar--R<sub>2</sub>--Ar)--NH--CO--O--(C<sub>2-50</sub>  
alkyl ester, C<sub>7-60</sub> aryl ester, C<sub>8-70</sub> alkylaryl ester, or  
C<sub>8-70</sub> arylalkyl ester)<sub>1-100</sub>, --R<sub>3</sub>--O--CO--NH--(R<sub>2</sub> or Ar--R<sub>2</sub>--  
Ar)--NH--CO--O--, --R<sub>1</sub>--O--CO--NH--(R<sub>2</sub> or Ar--R<sub>2</sub>--Ar)--NH--  
CO--NH--(C<sub>2-50</sub> alkyl amide, C<sub>7-60</sub> aryl amide, C<sub>8-70</sub>  
alkylaryl amide, or C<sub>8-70</sub> arylalkyl amide)<sub>1-100</sub>, or --R<sub>1</sub>--NH--  
CO--NH--(R<sub>2</sub> or Ar--R<sub>2</sub>--Ar)NH--CO--NH--(C<sub>2-50</sub> alkyl amide,  
C<sub>7-60</sub> aryl amide, C<sub>8-70</sub> alkylaryl amide, or C<sub>8-70</sub> arylalkyl  
amide)<sub>1-100</sub>;

each Z, independently, is --C--D--, wherein each C,  
independently, is --R--, --R--Ar--, --Ar--R--, or --Ar--;  
and each D, independently, is --OH, --SH, --NH<sub>2</sub>, --NHOH, --  
SO<sub>3</sub>H, --OSO<sub>3</sub>H, --COOH, --CONH<sub>2</sub>, --CO--NH--NH<sub>2</sub>, --CH(NH<sub>2</sub>)--  
COOH, --P(OH)<sub>3</sub>, --PO(OH)<sub>2</sub>, --O--PO(OH)<sub>2</sub>, --O--PO(OH)--O--  
PO(OH)<sub>2</sub>, --O--PO(O<sup>-</sup>)--O--CH<sub>2</sub>CH<sub>2</sub>NH<sub>3</sub><sup>+</sup>, -glycoside, --OCH<sub>3</sub>, --  
O--CH<sub>2</sub>--(CHOH)<sub>4</sub>--CH<sub>24</sub>--CH, --O--CH<sub>2</sub>--(CHOH)<sub>2</sub>--CHOH, --C<sub>6</sub>  
H<sub>3</sub>(OH)<sub>2</sub>, --NH<sub>3</sub><sup>+</sup>, --N<sup>+</sup>HR<sub>b</sub>R<sub>c</sub>, or N<sup>+</sup>HR<sub>b</sub>R<sub>c</sub>R<sub>d</sub>; wherein each of R,  
R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, R<sub>a</sub>, R<sub>b</sub>, R<sub>c</sub>, and R<sub>d</sub> independently, is C<sub>1-30</sub> alkyl,  
each Ar, independently, is aryl.

7. The organically-functionalized carbon  
nanocapsule as claimed in claim 1, wherein the carbon  
nanocapsule is functionalized by a redox reaction.

8. The organically-functionalized carbon  
nanocapsule as claimed in claim 1, wherein the carbon

nanocapsule is functionalized by a cycloaddition reaction.

9. The organically-functionalized carbon nanocapsule as claimed in claim 1, wherein the carbon nanocapsule is functionalized by a radical addition reaction.

10. An organically-functionalized carbon nanocapsule, comprising:

a carbon nanocapsule; and

at least one kind of organic functional groups bonded thereon,

wherein the organically-functionalized carbon nanocapsule is of the formula:

$F(-E)_n$ , in which F is the carbon nanocapsule, E is the organic functional group selected from -OH, -C=O, -CHO or -COOH, n is the number of the organic functional group, and the carbon nanocapsule F is functionalized by a redox reaction.

11. The organically-functionalized carbon nanocapsule as claimed in claim 10, wherein the carbon nanocapsule is a polyhedral carbon cluster constituting multiple graphite layers having a balls-within-a ball structure, and the diameter of a carbon nanocapsule is 3-100 nm.

12. The organically-functionalized carbon nanocapsule as claimed in claim 10, wherein the carbon nanocapsule is hollow.

1           13. The organically-functionalized carbon  
2 nanocapsule as claimed in claim 10, wherein the carbon  
3 nanocapsule is a metal-filled carbon nanocapsule filled  
4 with metals, metal oxides, metal carbides, or alloys.

1           14. The organically-functionalized carbon  
2 nanocapsule as claimed in claim 10, wherein n is 1-  
3 100,000.

1           15. An organically-functionalized carbon  
2 nanocapsule, comprising:

3           a carbon nanocapsule; and

4           at least one kind of organic functional groups  
5           bonded thereon,

6           wherein the organically-functionalized carbon  
7           nanocapsule is of the following formula:

8            $F(-E)_n$ , in which F is the carbon nanocapsule, E  
9           is the organic functional group selected  
10          from  $-NHAr$ ,  $-N^+(CH_3)_2Ar$ ,  $=CCl_2$  or amino  
11          group, n is the number of the organic  
12          functional group, and the carbon  
13          nanocapsule F is functionalized by a  
14          cycloaddition reaction.

1           16. The organically-functionalized carbon  
2 nanocapsule as claimed in claim 15, wherein the carbon  
3 nanocapsule is a polyhedral carbon cluster constituting  
4 multiple graphite layers having a balls-within-a ball  
5 structure, and the diameter of a carbon nanocapsule is 3-  
6 100 nm.

1           17. The organically-functionalized carbon  
2 nanocapsule as claimed in claim 15, wherein the carbon  
3 nanocapsule is hollow.

1           18. The organically-functionalized carbon  
2 nanocapsule as claimed in claim 15, wherein the carbon  
3 nanocapsule is a metal-filled carbon nanocapsule filled  
4 with metals, metal oxides, metal carbides, or alloys.

1           19. The organically-functionalized carbon  
2 nanocapsule as claimed in claim 15, wherein n is 1-  
3 100,000.

1           20. An organically-functionalized carbon  
2 nanocapsule, comprising:

3               a carbon nanocapsule; and

4               at least one kind of organic functional groups  
5               bonded thereon,

6               wherein the organically-functionalized carbon  
7               nanocapsule is of the following formula:

8                $F(-E)_n$ , in which F is the carbon nanocapsule, E  
9               is the organic functional group selected  
10              from -OH,  $-\text{OSO}_3^-$ ,  $-\text{C}(\text{CH}_3)_2\text{COOCH}_3$  or -  
11               $\text{C}(\text{CH}_3)_2\text{CN}$ , n is the number of the organic  
12              functional group, and the carbon  
13              nanocapsule F is functionalized by a  
14              radical addition reaction.

1           21. The organically-functionalized carbon  
2 nanocapsule as claimed in claim 20, wherein the carbon  
3 nanocapsule is a polyhedral carbon cluster constituting



multiple graphite layers having a balls-within-a ball structure, and the diameter of a carbon nanocapsule is 3-100 nm.

22. The organically-functionalized carbon nanocapsule as claimed in claim 20, wherein the carbon nanocapsule is hollow.

23. The organically-functionalized carbon nanocapsule as claimed in claim 20, wherein the carbon nanocapsule is a metal-filled carbon nanocapsule filled with metals, metal oxides, metal carbides, or alloys.

24. The organically-functionalized carbon nanocapsule as claimed in claim 20, wherein n is 1-100,000.